Honeywell

User Manual

SmartVFD COMPACT

Variable Frequency Drives for Constant and Variable Torque Applications

62-0312—02

User's Manual

Index

1. SAFETY

ONLY A COMPETENT ELECTRICIAN IS ALLOWED TO CARRY OUT THE ELECTRICAL INSTALLATION!

This manual contains clearly marked cautions and warnings which are intended for your personal safety and to avoid any unintentional damage to the product or connected appliances.

Please read the information included in cautions and warnings carefully:

= Dangerous voltage
Risk of death or severe injury

= General warning
Risk of damage to the product or connected appliances

1.1 WARNINGS

	**1**	The components of the power unit of the frequency converter are live when the VFD is connected to mains potential. Coming into contact with this voltage is extremely dangerous and may cause death or severe injury. The control unit is isolated from the mains potential.
	**2**	The motor terminals U, V, W (T1, T2, T3) and the possible brake resistor terminals -/+ are live when VFD is connected to mains, even if the motor is not running.
	**3**	The control I/O-terminals are isolated from the mains potential. However, the relay output terminals may have a dangerous control voltage present even when VFD is disconnected from mains.
	**4**	The ground leakage current of the variable frequency drive exceeds 3.5mA AC. According to standard EN61800-5-1, a reinforced protective ground connection must be ensured.
	**5**	If the frequency converter is used as a part of a machine, the machine manufacturer is responsible for providing the machine with a main switch (EN 60204-1).

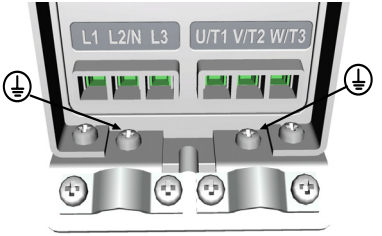
	**6**	If the VFD is disconnected from mains while running the motor, it remains live if the motor is energized by the process. In this case the motor functions as a generator feeding energy to the frequency converter.
	**7**	After disconnecting the frequency converter from the mains, wait until the fan stops and the indicators on the display go out. Wait 5 more minutes before doing any work on the VFD connections.

1.2 SAFETY INSTRUCTIONS

⚠	**1**	The variable frequency drive has been designed for fixed installations only.
⚠	**2**	Do not perform any measurements when the frequency converter is connected to the mains.
⚠	**3**	Do not perform any voltage withstand tests on any part of the VFD. The product safety is fully tested at factory.
⚠	**4**	Prior to measurements on the motor or the motor cable, disconnect the motor cable from the frequency converter.
⚠	**5**	Do not open the cover of VFD. Static voltage discharge from your fingers may damage the components. Opening the cover may also damage the device. If the cover of the VFD is opened, warranty becomes void.

1.3 GROUNDING AND GROUND FAULT PROTECTION

The Compact VFD **must always** be grounded with an grounding conductor connected to the grounding terminal. See figure below:



- The ground fault protection inside the frequency converter protects only the converter itself against ground faults.
- If fault current protective switches are used they must be tested with the drive with ground fault currents that are possible to arise in fault situations.

1.4 BEFORE RUNNING THE MOTOR

Checklist:

Before starting the motor, check that the motor is mounted properly and ensure that the machine connected to the motor allows the motor to be started.

Set the maximum motor speed (frequency) according to the motor and the machine connected to it.

Before reversing the motor shaft rotation direction make sure that this can be done safely.

Make sure that no power correction capacitors are connected to the motor cable.

2. RECEIPT OF DELIVERY

After unpacking the product, check that no signs of transport damages are to be found on the product and that the delivery is complete (compare the type designation of the product to the code below).

Should the drive have been damaged during the shipping, please contact primarily the cargo insurance company or the carrier.

If the delivery does not correspond to your order, contact the supplier immediately.

2.1 TYPE DESIGNATION CODE

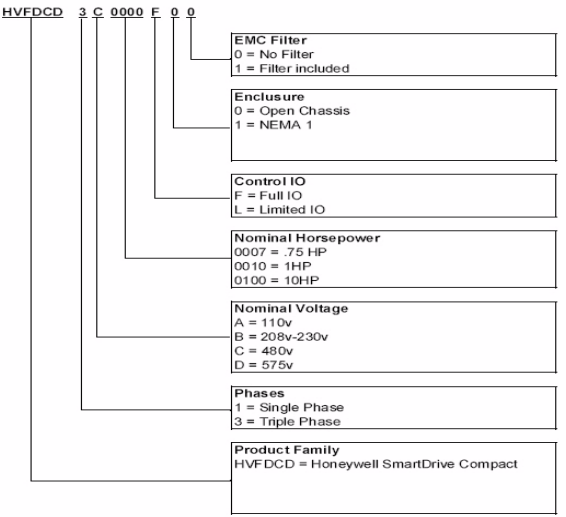


Figure 2.1: Type Code Designation

2.2 STORAGE

If the frequency converter is to be kept in store before use make sure that the ambient conditions are acceptable:

Storing temperature -40 °F(-40 °C)…+70 °F(21 °C)

Relative humidity < 95%, no condensation

2.3 MAINTENANCE

In normal operating conditions, Compact VFD are maintenance-free.

2.4 WARRANTY

Only manufacturing defects are covered by the warranty. The manufacturer assumes no responsibility for damages caused during or resulting from transport, receipt of the delivery, installation, commissioning or use.

The manufacturer shall in no event and under no circumstances be held responsible for damages and failures resulting from misuse, wrong installation, unacceptable ambient temperature, dust, corrosive substances or operation outside the rated specifications. Neither can the manufacturer be held responsible for consequential damages.

Variable frequency drive devices (VFD) and accessories: new products for thiry-six (36) months and factory refurbished drives for twelve (12) months from date of installation when start-up and commissioning is performed by Honeywell VFD Authorized and trained personnel. All VFD warranty return products must have priorauthorization (Form No. 87-0284) and be returned only to the VFD Service Center in Chattanooga, TN.

3. TECHNICAL DATA

3.1 COMPACT TECHNICAL DATA

Dimensions and weight	**Frame**	H (in)	W (in)	D (in)	Weight (lb)
	MI1	6.1	2.6	3.9	1.2
	MI2	7.7	3.5	4.0	1.5
	MI3	10.3	3.9	4.3	2.18
Supply network		Compact (400V) cannot be used with corner grounded networks			
Motor connection	Output voltage	0 - U_{in}			
	Output current	Continuous rated current I_N at ambient temperature max. 122 ºF (+50 ºC), overload 1.5 x I_N max. 1min/10min			
Ambient conditions	Ambient operating temperature	14 °F (-10 °C) (no frost)…122 °F (+50 °C): rated loadability I_N			
	Storage temperature	-40 °F (-40 °C)…+158 °F (+70 °C)			
	Relative humidity	0…95% RH, non-condensing, non-corrosive, no dripping water			
	Altitude	100% load capacity (no derating) up to 3280 ft. 1% derating for each 328 ft above 3280 ft; max. 6560 ft			
	Enclosure class	IP20 (open Chassis), option: NEMA 1			
EMC	Immunity	Complies with EN50082-1, -2, EN61800-3			
	Emissions	230V : Complies with EMC category C2 (Honeywell level H); With an internal RFI filter 400V: Complies with EMC category C2 (Honeywell level H): With an internal RFI filter Both: No EMC emission protection (Honeywell level N): Without RFI filter			
Standards		For EMC: EN61800-3, For safety: UL508C, EN61800-5-1			
Certificates and manufacturer's declarations of conformity		For safety: CB, CE, UL, cUL, For EMC: CE, CB, c-tick (see unit nameplate for more detailed approvals)			

Table 3.1 : Technical data

3.2 POWER RATINGS

3.2.1 Mains voltage 208 - 240 V

Mains voltage 208-240 V, 50/60 Hz, 1~ series					
Product code	Rated loadability		Motor shaft power	Nominal input current	Mechanical size and weight (lb)
	100% contin. current I_N [A]	150% overload current [A]	P [HP]	[A]	
HVFDCD1B0003xxx	1.7	2.6	0.25	4.2	MI1 1.2
HVFDCD1B0005xxx	2.4	3.6	0.5	5.7	MI1 1.2
HVFDCD1B0007xxx	2.8	4.2	0.75	6.6	MI1 1.2
HVFDCD1B0010xxx	3.7	5.6	1	8.3	MI1 1.2
HVFDCD1B0015xxx	4.8	7.2	1.5	11.2	MI2 1.5
HVFDCD1B0020xxx	7.0	10.5	2	14.1	MI2 1.5
HVFDCD1B0030xxx	9.6	14.4	3	15.8	MI3, 2.18

Table 3.2 : Power ratings, 208 - 240 V

3.2.2 Mains voltage 380 - 480 V

Mains voltage 380-480 V, 50/60 Hz, 3~ series					
Product code	Rated loadability		Motor shaft power	Nominal input current	Mechanical size and weight (lb)
	100% continuous current I_N [A]	150% overload current [A]	380-480V supply P[HP]	[A]	
HVFDCD3C0005xxx	1.3	2.0	0.5	2.2	MI1 1.2
HVFDCD3C0007xxx	1.9	2.9	0.75	2.8	MI1 1.2
HVFDCD3C0010xxx	2.4	3.6	1	3.2	MI1 1.2
HVFDCD3C0015xxx	3.3	5.0	1.5	4.0	MI1 1.2
HVFDCD3C0020xxx	4.3	6.5	2	5.6	MI2 1.5
HVFDCD3C0030xxx	5.6	8.4	3	7.3	MI2 1.5
HVFDCD3C0040xxx	7.6	11.4	4	9.6	MI3, 2.18
HVFDCD3C0050xxx	9.0	13.5	5	11.5	MI3, 2.18
HVFDCD3C0075xxx	12.0	18.0	7.5	14.9	MI3, 2.18

Table 3.3 : Power ratings, 380 - 480 V

Note 1: The input currents are calculated values with 100 kVA line transformer supply.

Note 2: The mechanical dimensions of the units are given in Chapter 4.1.1.

4. INSTALLATION

4.1 MECHANICAL INSTALLATION

There are two possible ways to mount the Compact VFD to the wall - either screw or DIN-rail mounting. The mounting dimensions are given on the back of the drive and on the following page.

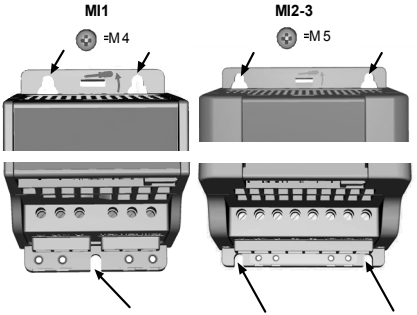


Figure 4.1: Screw mounting

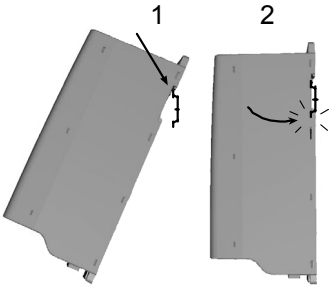


Figure 4.2: DIN-rail mounting

4.1.1 Dimensions

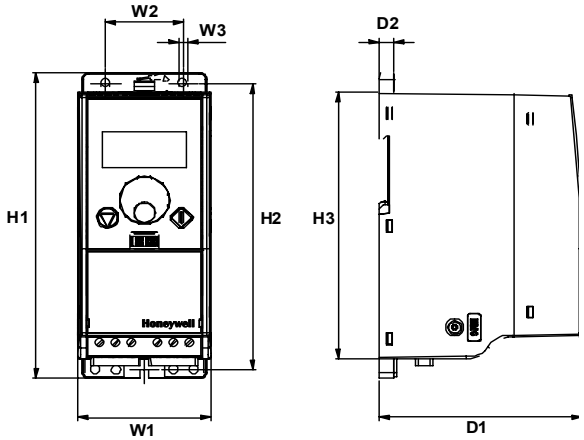


Figure 4.3: Dimensions, MI1-MI3

Type	H1	H2	H3	W1	W2	W3	D1	D2
MI1	6.2	5.8	5.4	2.6	1.5	0.2	3.9	0.3
MI2	7.7	7.2	6.7	3.5	2.5	0.2	4	0.3
MI3	10.3	9.9	9.5	3.9	3.0	0.2	4.3	0.3

Table 4.1 : Dimensions in inches

4.1.2 Cooling

Forced air flow cooling is used in all Compact VFDs.
Enough free space must be left above and below the frequency converter to ensure sufficient air circulation and cooling. The required dimensions for free space are given in the table below:

Type	Dimensions (inch)	
	A	B
MI1	3.9	2.0
MI2	3.9	2.0
MI3	3.9	2.0

Table 4.2 : Dimensions required for cooling

Type	Cooling air required (CFM)
MI1	5.89
MI2	5.89
MI3	17.7

Table 4.3 : Required cooling air

4.1.3 EMC levels

Compact frequency converters are divided into five classes according to the level of electromagnetic disturbances emitted, the requirements of a power system network and the installation environment (see below). The EMC class of each product is defined in the type designation code.

Category C1: Frequency converters of this class comply with the requirements of category C1 of the product standard EN 61800-3 (2004). Category C1 ensures the best EMC characteristics and it includes converters the rated voltage of which is less than 1000V and which are intended for use in the 1st environment. NOTE: The requirements of class C are fulfilled only as far as the conducted emissions are concerned.

Category C2: Frequency converters of this class comply with the requirements of category C2 of the product standard EN 61800-3 (2004). Category C2 includes converters in fixed installations and the rated voltage of which is less than 1000V. The class H frequency converters can be used both in the 1st and the 2nd environment.

Category C3: Frequency converters of this class comply with the requirements of category C3 of the product standard EN 61800-3 (2004). Cateory C3 includes converters the rated voltage of which is less than 1000V and which are intended for use in the second environment only.

Category C4: The drives of this class do not provide EMC emission protection. These kinds of drives are mounted in enclosures. NOTE: An external EMC filter is usually required to fulfil the EMC emission requirements.

Category C4 for IT networks: Frequency converters of this class fulfil the product standard EN 61800-3 (2004) if intended to be used in IT systems. In IT systems, the networks are isolated from ground, or connected to ground through high impedance to achieve a low leakage current. NOTE: if converters are used with other supplies, no EMC requirements are complied with.

Environments in product standard EN 61800-3 (2004)

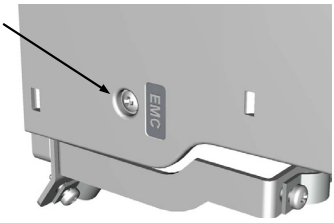
First environment: Environment that includes domestic premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes.

NOTE: houses, apartments, commercial premises or offices in a residential building are examples of first environment locations.

Second environment: Environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes.
NOTE: industrial areas, technical areas of any building fed from a dedicated transformer are examples of second environment locations.

4.1.4 Changing the EMC protection class from H or L to T

The EMC protection class of Compact frequency converters can be changed from class H or L to class T by **removing the EMC-capacitor disconnecting screw**, see figure below.
Note! Do not attempt to change the EMC level back to class H or L. Even if the procedure above is reversed, the frequency converter will no longer fulfil the EMC requirements of class H/L!



4.2 CABLING AND CONNECTIONS

4.2.1 Power cabling

Note! Tightening torque for power cables is 4 - 5 in-lbs.

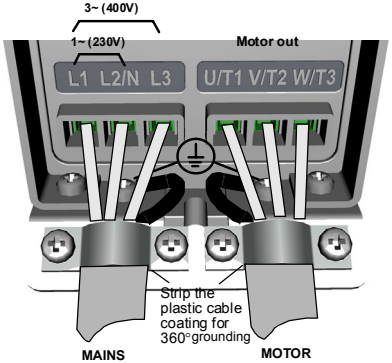


Figure 4.4: Power connections, MI1

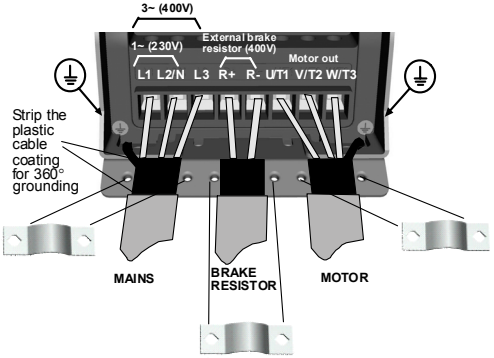


Figure 4.5: Power connections, MI2 - MI3

4.2.2 Control cabling

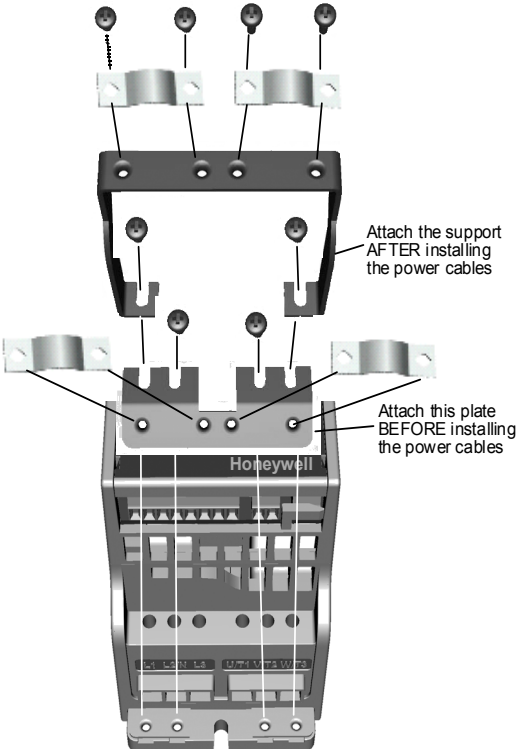


Figure 4.6: Mount the PE- plate and API cable support

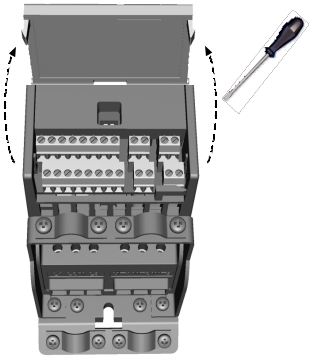


Figure 4.7: Open the cover

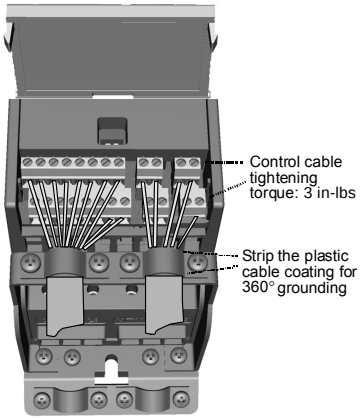


Figure 4.8: Install the control cables. See Chapter 7.2

4.2.3 Cable and fuse specifications

Use cables with heat resistance of at least 158 °F (+70 °C). The cables and the fuses must be sized according to the tables below. Installation of cables according to UL regulations is presented in Chapter 4.2.6.

The fuses also function as cable overload protection.
These instructions apply only to cases with one motor and one cable connection from the frequency converter to the motor. In any other case, ask the factory for more information.

EMC class	Level H	Level L	Level N
Mains cable types	1	1	1
Motor cable types	3	2	1
Control cable types	4	4	4

Table 4.4 : Cable types required to meet standards. EMC levels are described in Chapter 4.1.3.

Cable type	Description
1	Power cable intended for fixed installation and the specific mains voltage. Shielded cable not required. (NKCABLES/MCMK or similar recommended)
2	Power cable equipped with concentric protection wire and intended for the specific mains voltage. (NKCABLES /MCMK or similar recommended).
3	Power cable equipped with compact low-impedance shield and intended for the specific mains voltage. (NKCABLES /MCCMK, SAB/ÖZCUY-J or similar recommended). *360º grounding of both motor and FC connection required to meet the standard
4	Screened cable equipped with compact low-impedance shield (NKCABLES /Jamak, SAB/ÖZCuY-O or similar).

Table 4.5 : Cable type descriptions

Frame	Type	I_N [A]	Fuse [A]	Mains cable Cu [AWG]	Terminal cable size (min/max)			
					Main terminal [AWG]	Ground terminal [AWG]	Control terminal [AWG]	Relay terminal [AWG]
MI1	P25 - P75	1,7-3,7	10	2*15+15	15-11	15-11	20-15	20-15
MI2	1P1 - 1P5	4,8-7,0	20	2*13+13	15-11	15-11	20-15	20-15
MI3	2P2	11	32	2*9+9	15-9	15-9	20-15	20-15

Table 4.6 : Cable and fuse sizes for 208 - 240V

Frame	Type	I_N [A]	Fuse [A]	Mains cable Cu [AWG]	Terminal cable size (min/max)			
					Main terminal [AWG]	Ground terminal [AWG]	Control terminal [AWG]	Relay terminal [AWG]
MI1	P37 - 1P1	1,9-3,3	6	3*15+15	15-11	15-11	20-15	20-15
MI2	1P5 - 2P2	4,3-5,6	10	3*15+15	15-11	15-11	20-15	20-15
MI3	3P0 - 5P5	7,6 - 12	20	3*13+13	15-9	15-9	20-15	20-15

Table 4.7 : Cable and fuse sizes for 380 - 480V

Note! To fulfil standard EN61800-5-1, the protective conductor should be **at least AWG 7 Cu or AWG 5 Al**. Another possibility is to use an additional protective conductor of at least the same size as the original one.

4.2.4 General cabling rules

1	Before starting the installation, check that none of the components of the frequency converter is live.
2	Place the motor cables sufficiently far from other cables: • **Avoid** placing the motor cables in long **parallel lines** with other cables • If the motor cable runs in parallel with other cables, the **minimum distance** between the motor cable and other cables is **11.8 inches**. • The given distance also applies between the motor cables and signal cables of other systems. • The **maximum length** of the motor cables is **100 feet**. • The **motor cables** should cross other cables at an angle of **90 degrees**.
3	If cable insulation checks are needed, see Chapter 4.2.7.
4	Connecting the cables: • Strip the motor and mains cables as advised in Figure 4.9. • Connect the mains, motor and control cables into their respective terminals, see Figures 4.4 - 4.8. • Note the tightening torques of **power cables and control cables** given in page 15 and page 17. • For information on cable installation according to UL regulations see Chapter 4.2.6 . • Make sure that the control cable wires do not come in contact with the electronic components of the unit • If an **external brake resistor** (option) is used, connect its cable to the appropriate terminal. • **Check the connection** of the ground cable to the motor and the frequency converter terminals marked with • Connect the **separate shield of the motor cable to the ground plate** of the frequency converter, motor and the supply centre

4.2.5 Stripping lengths of motor and mains cables

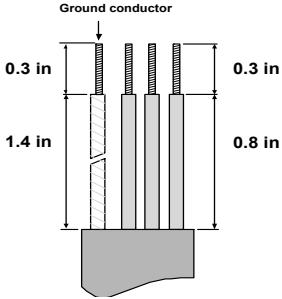


Figure 4.9: Stripping of cables

Note! Strip also the plastic cover of the cables for 360 degree grounding. See Figures 4.4, 4.5 and 4.8.

4.2.6 Cable installation and the UL standards

To meet the UL (Underwriters Laboratories) regulations, a UL-approved copper cable with a minimum heat-resistance of 140/167 °F (+60/75 °C) must be used.

4.2.7 Cable and motor insulation checks

These checks can be performed as follows if motor or cable insulations are suspected to be faulty.

1. Motor cable insulation checks

Disconnect the motor cable from terminals U/T1, V/T2 and W/T3 of the frequency converter and from the motor. Measure the insulation resistance of the motor cable between each phase conductor as well as between each phase conductor and the protective ground conductor.

The insulation resistance must be >1MOhm.

2. Mains cable insulation checks

Disconnect the mains cable from terminals L1, L2/N and L3 of the frequency converter and from the mains. Measure the insulation resistance of the mains cable between each phase conductor as well as between each phase conductor and the protective ground conductor.The insulation resistance must be >1MOhm.

3. Motor insulation checks

Disconnect the motor cable from the motor and open the bridging connections in the motor connection box. Measure the insulation resistance of each motor winding. The measurement voltage must equal at least the motor nominal voltage but not exceed 1000 V. The insulation resistance must be >1MOhm.

5. COMMISSIONING

Before commissioning, note the warnings and instructions listed in Chapter 1!

5.1 COMMISSIONING STEPS

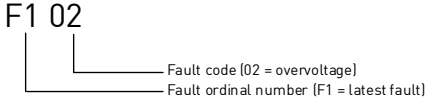
1	Read carefully the safety instructions in Chapter 1 and follow them.
2	After the installation, make sure that: • both the frequency converter and the motor are grounded • the mains and motor cables comply with the requirements given in Chapter 4.2.3 • the control cables are located as far as possible from the power cables (see Chapter , step 2) and the shields of the shielded cables are connected to protective ground 
3	Check the quality and quantity of cooling air (Chapter 4.1.2)
4	Check that all Start/Stop switches connected to the I/O terminals are in **Stop**-position.
5	Connect the frequency converter to mains
Note: The following steps are valid if you have API Full or API Limited Application Interface.	
6	Set the parameters of group 1 according to the requirements of your application. At least the following parameters should be set: • motor nominal voltage (par. 1.1) • motor nominal frequency (par. 1.2) • motor nominal speed (par. 1.3) • motor nominal current (par. 1.4) You will find the values needed for the parameters on the motor rating plate

7	Perform test run **without motor**. Perform either Test A or Test B: **A)** Control from the I/O terminals: • Turn the Start/Stop switch to ON position. • Change the frequency reference (potentiometer) • Check in the Monitoring Menu that the value of Output frequency changes according to the change of frequency reference. • Turn the Start/Stop switch to OFF position **B)** Control from the keypad: • Select the keypad as the control place with par. 2.1. You can also move to keypad control by pressing the navigation wheel for 5 seconds. • Push the Start button on the keypad • Check in the Monitoring Menu that the value of Output frequency changes according to the change of frequency reference • Push the Stop button on the keypad
8	Run the no-load tests without the motor being connected to the process, if possible. If this is not possible, secure the safety of each test prior to running it. Inform your co-workers of the tests. • Switch off the supply voltage and wait up until the drive has stopped. • Connect the motor cable to the motor and to the motor cable terminals of the frequency converter. • See to that all Start/Stop switches are in Stop positions. • Switch the mains ON • Repeat test 7A or 7B
9	Connect the motor to the process (if the no-load test was run without the motor being connected) • Before running the tests, make sure that this can be done safely. • Inform your co-workers of the tests. • Repeat test 7A or 7B.

6. FAULT TRACING

Note: The fault codes listed in this chapter are visible if the Application Interface has a display, like e.g. in API FULL or API LIMITED or if a personal computer has been connected to the drive

When a fault is detected by the frequency converter control electronics, the drive is stopped and the symbol F together with the ordinal number of the fault and the fault code appear on the display in the following format, e.g:



The fault can be reset by pressing the Stop button on the control keypad or via the I/O terminal or fieldbus. The faults with time labels are stored in the Fault history menu which can be browsed. The different fault codes, their causes and correcting actions are presented in the table below.

Fault code	Fault name	Possible cause	Correcting actions
1	Overcurrent	Frequency converter has detected too high a current (>4*I_N) in the motor cable: • sudden heavy load increase • short circuit in motor cables • unsuitable motor	Check loading. Check motor size. Check cables.
2	Overvoltage	The DC-link voltage has exceeded the internal safety limit: • too short a deceleration time • high overvoltage spikes in mains	Increase the deceleration time (P.4.3)
3	Ground fault	Current measurement has detected extra leakage current at start: • insulation failure in cables or motor	Check motor cables and motor

Table 6.1 : Fault codes

Fault code	Fault name	Possible cause	Correcting actions
8	System fault	• component failure • faulty operation	Reset the fault and restart. Should the fault re-occur, contact the distributor near to you
9	Undervoltage	The DC-link voltage has exceeded the internal safety limit: • most probable cause: too low a supply voltage • frequency converter internal fault • Power outages	In case of temporary supply voltage break reset the fault and restart the frequency converter. Check the supply voltage. If it is adequate, an internal failure has occurred. Contact the distributor near to you
13	Frequency converter undertemperature	IGBT switch temperature is under 14 °F(-10 °C)	Check the ambient temperature
14	Frequency converter overtemperature	IGBT switch temperature is over 248 °F (120 °C). Overtemperature warning is issued when the IGBT switch temperature exceeds 230 °F (110 °C).	Check that the cooling air flow is not blocked. Check the ambient temperature. Make sure that the switching frequency is not too high in relation to ambient temperature and motor load.
15	Motor stalled	Motor stall protection has tripped	Check motor
16	Motor overtemperature	Motor overheating has been detected by frequency converter motor temperature model. Motor is overloaded	Decrease the motor load. If no motor overload exists, check the temperature model parameters.
22	EEPROM checksum fault	Parameter save fault • faulty operation • component failure	Contact the distributor near to you
25	Microcontroller watchdog fault	• faulty operation • component failure	Reset the fault and restart. Should the fault re-occur, contact the distributor near to you.
34	Internal bus communication	Ambient interference or defective hardware	Should the fault re-occur, contact the distributor near to you.

Table 6.1 : Fault codes

Fault code	Fault name	Possible cause	Correcting actions
35	Application fault	Application does not function	Contact the distributor near to you
50	Analogue input I_{in} < 4mA (selected signal range 4 to 20 mA)	Current at the analogue input is < 4mA • control cable is broken or loose • signal source has failed	Check the current loop circuitry
51	External fault	Digital input fault. Digital input has been programmed as external fault input and this input is active.	Check the programming and the device indicated by the external fault information. Check also the cabling of this device.
53	Fieldbus fault	The data connection between the fieldbus Master and the fieldbus of the drive broken	Check installation. If installation is correct contact the nearest Honeywell distributor.

Table 6.1 : Fault codes

7. APPLICATION INTERFACE

7.1 INTRODUCTION

There are three versions of Application Interfaces (API) available:
:

API Full	API Limited	API RS-485 (Modbus RTU)
6 Digital inputs	3 Digital inputs	1 Digital input
2 Analogue inputs	1 Analogue input	1 Relay output
1 Analogue output	1 Relay output	RS-485 Interface
1 Digital output	RS-485 Interface	
2 Relay outputs		
RS-485 Interface		

Table 7.1 : Available Application Interfaces

This section provides you with a description of the I/O-signals for these versions and instructions for using the general purpose application.

The frequency reference can be selected from the analogue inputs, fieldbus, preset speeds or keypad.

Basic properties:

- Digital inputs DI1…DI6 are freely programmable. The user can assign a single input to many functions
- Digital-, relay- and analogue outputs are freely programmable
- Analogue input 1 can be programmed as current or voltage input in API Limited version

Special features in all API versions:

- Programmable Start/Stop and Reverse signal logic
- Reference scaling
- Programmable start and stop functions
- DC-brake at start and stop
- Programmable U/f curve
- Adjustable switching frequency
- Autorestart function after fault
- Protections and supervisions (all fully programmable; off, warning, fault):

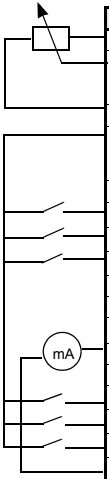
- Current signal input fault
- External fault
- Undervoltage fault
- Ground fault
- Motor thermal, stall and underload protection
- Fieldbus communication

Special features in API Full and API Limited:

- 8 preset speeds
- Analogue input range selection, signal scaling and filtering
- PI-controller

7.2 CONTROL I/O

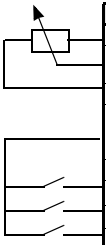
API FULL



Terminal		Signal	Factory preset	Description
1	+10Vre	Ref. voltage out		Maximum load 10 mA
2	AI1	Analog signal in 1	Freq. reference P)	0 - +10 V Ri = 200 kΩ (min)
3	GND	I/O signal ground		
6	24Vout	24V output for DI's		±20 %, max. load 50 mA
7	GND	I/O signal ground		
8	DI1	Digital input 1	Start forward P)	0 - +30 V Ri = 12 kΩmin
9	DI2	Digital input 2	Start reverse P)	
10	DI3	Digital input 3	Preset speed B0 P)	
A	A	RS485 signal A	FB Communication	
B	B	RS485 signal B	FB Communication	
4	AI2	Analog signal in 2	PI actual value P)	0(4) - 20 mA, Ri = 200Ω
5	GND	I/O signal ground		
13	GND	I/O signal ground		
14	DI4	Digital input 4	Preset speed B1 P)	0 - +30 V Ri = 12 kΩ (min)
15	DI5	Digital input 5	Fault reset P)	
16	DI6	Digital input 6	Disable PI contr. P)	
18	AO		Output frequency P)	0(4) - 20 mA, RL = 500Ω
20	DO	Digital signal out	Active = READY P)	Open collector, max. load 48V/50mA
22	RO 11	Relay out 1	Active = RUN P)	Max. switching load: 250Vac/2A or 250Vdc/ 0.4A
23	RO 12			
24	RO 21	Relay out 2	Active = FAULT P)	Max. switching load: 250Vac/2A or 250Vdc/ 0.4A
25	RO 22			
26	RO 23			

Table 7.2 : General purpose application default I/O configuration and connections for API FULL version
P) = Programmable function, see parameter lists and descriptions, chapters 9 and 10.

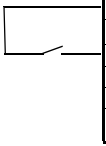
API LIMITED



Terminal		Signal	Factory preset	Description
1	+10Vre	Ref. voltage out		Maximum load 10 mA
2	AI1	Analog signal in 1	Freq. reference P)	0 - +10 V Ri = 200 kΩ
3	GND	I/O signal ground		
6	24Vout	24V output for DI's		±20 %, max. load 50 mA
7	GND	I/O signal ground		
8	DI1	Digital input 1	Start forward P)	0 - +30 V Ri = 12 kΩmin
9	DI2	Digital input 2	Start reverse P)	
10	DI3	Digital input 3	Preset speed B0 P)	
A	A	RS485 signal A	FB Communication	
B	B	RS485 signal B	FB Communication	
24	RO 21	Relay out 2	ACTIVE (Relay opened) = FAULT P)	Max. switching load: 250Vac/2A or 250Vdc/ 0.4A
25	RO 22			

Table 7.3 : General purpose application default I/O configuration and connections for API LIMITED version
P) = Programmable function, parameter lists and descriptions, chapters 9 and 10.

API RS-485



Terminal		Signal	Factory preset	Description
3	GND	I/O signal ground		
6	24Vout	24V output for DI's		±20 %, max. load 50 mA
7	GND	I/O signal ground		
8	DI1	Digital input 1	1 = Start forward	0 - +30 V Ri = 12 kΩmin
A	A	RS485 signal A	FB Communication	
B	B	RS485 signal B	FB Communication	
24	RO 21	Relay out 2	ACTIVE (Relay opened) = FAULT P)	Max. switching load: 250Vac/2A or 250Vdc/ 0.4A
25	RO 22			

Table 7.4 : General purpose application default I/O configuration and connections for API RS-485 version
P) = Programmable function, parameter lists and descriptions, chapters 9 and 10.

8. CONTROL PANEL

8.1 GENERAL

The API Full and API Limited versions have similar control panels.
The panel is integrated to the drive consisting of corresponding application card and an overlay on the drive cover with status display and button clarifications.

The Control panel consists of an LCD display with backlight and a keypad including a navigation wheel, a green START button and a red STOP button (see Figure 8.1).

8.2 DISPLAY

The display includes 14-segment and 7-segment blocks, arrowheads and clear text unit symbols. The arrowheads, when visible, indicate some information about the drive, which is printed in clear text on the overlay (numbers 1…14 in the figure below). The arrowheads are grouped in 3 groups with the following meanings and English overlay texts (see Figure 8.1):

Group 1 - 5; Drive status

1= Drive is ready to start (READY)
2= Drive is running (RUN)
3= Drive has stopped (STOP)
4= Alarm condition is active (ALARM)
5= Drive has stopped due to a fault (FAULT)

Group 6 - 10; Control selections

6= Motor is rotating forward (FWD)
7= Motor is rotating reverse (REV)
8= I/O terminal block is the selected control place (I/O)
9= Keypad is the selected control place (KEYPAD)
10= Fieldbus is the selected control place (BUS)

Group 11 - 14; Navigation main menu

11= Reference main menu (REF)
12= Monitoring main menu (MON)
13= Parameter main menu (PAR)
14= Fault history main menu (FLT)

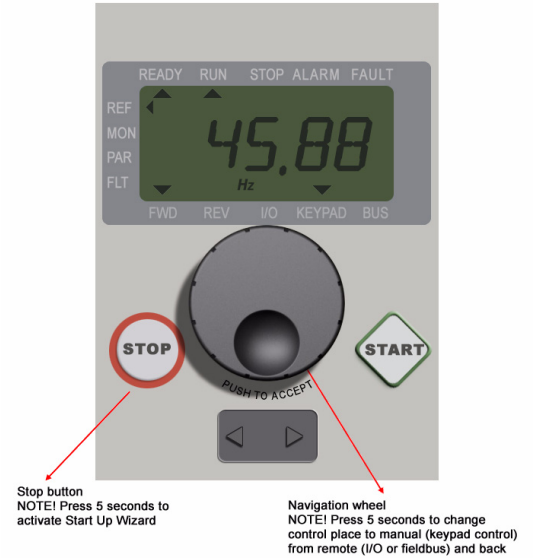


Figure 8.1: Control panel

8.3 KEYPAD

The keypad section of the control panel consists of a navigation wheel and START and STOP buttons (see Figure 8.1). The navigation wheel is used for navigating on the panel display, but it also works as a reference potentiometer when KEYPAD has been selected as the control place of the drive. The wheel has two separate functions;

- rotating the wheel e.g. for changing parameter value (12 steps / round)
- pressing the wheel e.g. for accepting the new value.

The drive stops always, regardless of the selected control place, by pressing the keypad STOP button. The drive starts by pressing the keypad START button, but only if the selected control place is KEYPAD.

8.4 NAVIGATION ON THE CONTROL PANEL

This chapter provides you with information on navigating the menus on the VFD and editing the values of the parameters.

8.4.1 Main menu

The menu structure of the control software consists of a main menu and several submenus. Navigation in the main menu is shown below:

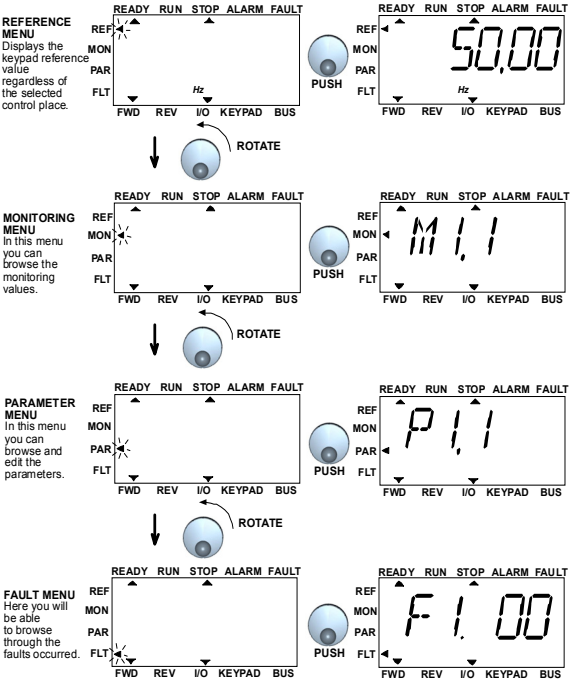


Figure 8.2: Main menu

8.4.2 Reference menu

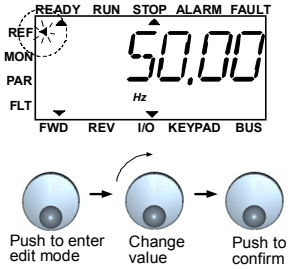


Figure 8.3: Reference menu display

Move to the reference menu with the navigation wheel (see Figure 8.2). The reference value can be changed with the navigation wheel as shown in Figure 8.3. The reference value follows the rotation continuously (= without separate new value acceptance) .

8.4.3 Monitoring menu

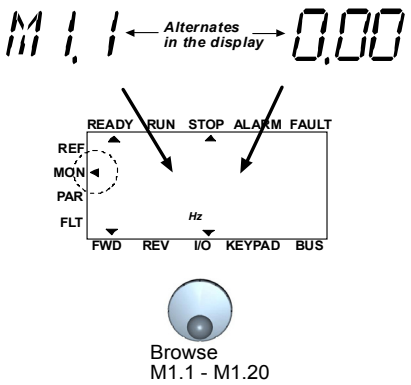


Figure 8.4: Monitoring menu display

Monitoring values mean actual values of measured signals as well as statuses of some control settings. They are visible in API Full and Limited display, but they cannot be edited. The monitoring values are listed in Table 8.1.

Pushing the navigation wheel once in this menu takes the user to the next level, where the monitoring value, e.g. M1.11 and value are visible (see Figure 8.2). The monitoring values can be browsed by rolling the navigation wheel clockwise, as shown in Figure 8.4.

Code	Monitoring signal	Unit	ID	Description
M1.1	Output frequency	Hz	1	Frequency to the motor
M1.2	Frequency reference	Hz	25	
M1.3	Motor shaft speed	rpm	2	Calculated motor speed
M1.4	Motor current	A	3	Measured motor current
M1.5	Motor torque	%	4	Calculated actual/nominal torque of the motor
M1.6	Motor power	%	5	Calculated actual/nominal power of the motor

Table 8.1 : Monitoring signals

Code	Monitoring signal	Unit	ID	Description
M1.7	Motor voltage	V	6	Motor voltage
M1.8	DC-link voltage	V	7	Measured DC-link voltage
M1.9	Unit temperature	C°	8	Heat sink temperature
M1.10	Motor temperature	C°		Calculated motor temperature
M1.11	Analogue input 1	%	13	AI1 value
M1.12	Analogue input 2	%	14	AI2 value **ONLY IN API FULL!**
M1.13	Analogue output	%	26	AO1 **ONLY IN API FULL!**
M1.14	DI1, DI2, DI3		15	Digital input statuses
M1.15	DI4, DI5, DI6		16	Digital input statuses **ONLY IN API FULL!**
M1.16	RO1, (also RO2, DO in API FULL)		17	Relay/digital output statuses
M1.17	PI setpoint	%	20	In percent of the maximum process reference
M1.18	PI feedback	%	21	In percent of the maximum actual value
M1.19	PI error value	%	22	In percent of the maximum error value
M1.20	PI Output	%	23	In percent of the maximum output value

Table 8.1 : Monitoring signals

8.4.4 Parameter menu

In Parameter menu only the Quick setup parameter list is shown by default. By giving the right value to the parameter 13.1 it is possible to open other advanced parameter groups. The parameter lists and descriptions can be found in chapters 9 and 10.

The following figure shows the parameter menu view:

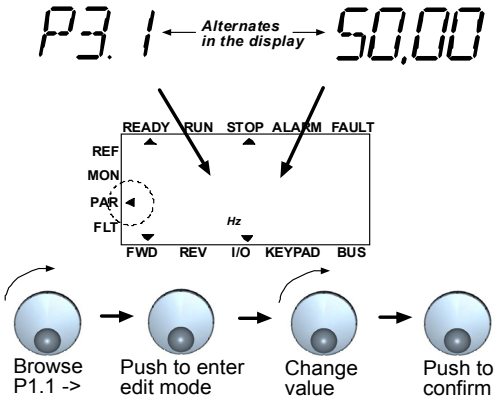


Figure 8.5: Parameter menu

8.4.5 Fault history menu

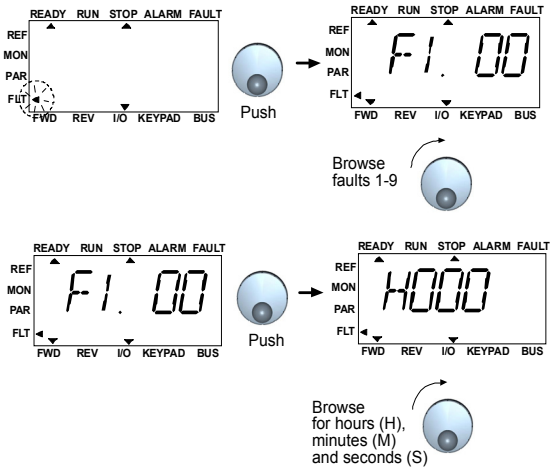


Figure 8.6: Fault history menu

In Fault history menu you can browse through 9 latest faults (see Figure 8.6). If a fault is active, the relevant fault number (e.g. F1 02) alternates in the display with main menu. When you browse between the faults, the fault codes of active faults are blinking. The active faults can be reset by pressing the STOP button for 1 second. If the fault cannot be reset, the blinking continues. It is possible to navigate in the menu structure also when there are active faults present, but the display returns automatically to the fault menu if buttons or navigation wheel are not pressed or navigation is not rotated. The operating hour, minute and second values at the fault instant are shown in the value menu (operating hours = displayed reading x 1000 h).

Note! The whole fault history can be cleared by pressing STOP button for 5 sec time when the drive is stopped and Fault history menu is selected in the display.

See Chapter 6 in for fault descriptions

9. GENERAL PURPOSE APPLICATION PARAMETERS

On the next pages you can find the lists of parameters within the respective parameter groups. The parameter descriptions are given in Chapter 10.

NOTE: Parameters can only be changed when drive is in stop mode!

Explanations:

Code:	Location indication on the keypad; Shows the operator the present Monitoring value number or Parameter number
Parameter:	Name of monitoring value or parameter
Min:	Minimum value of parameter
Max:	Maximum value of parameter
Unit:	Unit of parameter value; given if available
Default:	Factory preset value
ID:	ID number of the parameter (used with fieldbus control)
☞	More information on this parameter available in chapter 10: 'Parameter descriptions' click on the parameter name.

9.1 QUICK SETUP PARAMETERS (VIRTUAL MENU, SHOWS WHEN PAR. 13.1 = 1)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.1	Motor nominal voltage	180	500	V	230 400	110	Check rating plate on the motor
P1.2	Motor nom. frequency	30	320	Hz	60.00	111	Check rating plate on the motor
P1.3	Motor nominal speed	300	20000	rpm	1440	112	Default applies for a 4-pole motor.
P1.4	Motor nominal current	0.2 x I_{Nunit}	1.5 x I_{Nunit}	A	I_{Nunit}	113	Check rating plate on the motor
P1.5	Motor cos φ	0.30	1.00		0.85	120	Check rating plate on the motor
P1.7	Current limit	0.2 x I_{Nunit}	2 x I_{Nunit}	A	1.5 x I_{Nunit}	107	
P1.15	Torque boost	0	1		0	109	**0** = Not used **1** = Used
P2.1	Control place	1	3		1	125	**1** = I/O terminal **2** = Keypad **3** = Fieldbus
P2.2	Start function	0	1		0	505	**0** = Ramp **1** = Flying start
P2.3	Stop function	0	1		0	506	**0** = Coasting **1** = Ramp
P3.1	Min frequency	0.00	P3.2	Hz	0.00	101	
P3.2	Max frequency	P3.1	320	Hz	50.00	102	
P3.3	I/O reference	0	4		3	117	**0** = Preset Speeds (0-7) **1** = Keypad Reference **2** = Fieldbus Reference **3** = AI1 **(API FULL & LIMITED)** **4** = AI2 **(API FULL)**
P3.4	Preset speed 0	0.00	P3.2	Hz	5.00	124	Activated by digital inputs
P3.5	Preset speed 1	0.00	P3.2	Hz	10.00	105	Activated by digital inputs
P3.6	Preset speed 2	0.00	P3.2	Hz	15.00	106	Activated by digital inputs
P3.7	Preset speed 3	0.00	P3.2	Hz	20.00	126	Activated by digital inputs
P4.2	Acceleration time	0.1	3000	s	1.0	103	Acceleration time from 0 Hz to maximum frequency

Table 9.1: Quick setup parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P4.3	Deceleration time	0.1	3000	s	1.0	104	Deceleration time from maximum frequency to 0 Hz.
P6.1	AI1 Signal range	0	3		0	379	**API FULL and LIMITED:** **0** = Voltage 0…10 V **1** = Voltage 2…10 V **API LIMITED ONLY:** **2** = Current 0…20 mA **3** = Current 4…20 mA **NOTE:** When using API LIMITED, select the voltage/current range also with the dip switch
P6.5	AI2 Signal range (API Full only)	2	3		3	390	**2** = Current 0…20 mA **3** = Current 4…20 mA
P10.4	Automatic restart	0	1		0	731	**0** = Not used **1** = Used
P13.1	Parameter conceal	0	1		1	115	**0** = All parameters visible **1** = Only quick setup parameter group visible

Table 9.1: Quick setup parameters

9.2 MOTOR SETTINGS (CONTROL PANEL: MENU PAR -> P1)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.1	Motor nominal voltage	180	500	V	230 400	110	Check rating plate on the motor
P1.2	Motor nominal frequency	30	320	Hz	60.00	11	Check rating plate on the motor
P1.3	Motor nominal speed	300	20000	rpm	1440	112	Default applies for a 4-pole motor.
P1.4	Motor nominal current	0.2 x I_{Nunit}	1.5 x I_{Nunit}	A	I_{Nunit}	113	Check rating plate on the motor
P1.5	Motor cos φ	0.30	1.00		0.85	120	Check rating plate on the motor
P1.7	Current limit	0.2 x I_{Nunit}	2 x I_{Nunit}	A	1.5 x I_{Nunit}	107	
P1.8	Motor control mode	0	1		0	600	**0** = Frequency control **1** = Speed control
P1.9	U/f ratio selection	0	2		0	108	**0** = Linear **1** = Squared **2** = Programmable
P1.10	Field weakening point	30.00	320	Hz	50.00	602	
P1.11	Voltage at field weakening point	10.00	200	%	100.00	603	% of Nominal voltage of the motor
P1.12	U/f curve midpoint frequency	0.00	P1.10	Hz	25.00	604	
P1.13	U/f curve midpoint voltage	0.00	P1.11	%	50.00	605	% of Nominal voltage of the motor
P1.14	Output voltage at zero frequency	0.00	40.00	%	0.00	606	% of Nominal voltage of the motor
P1.15	Torque boost	0	1		0	109	**0** = Not used **1** = Used
P1.16	Switching frequency	1.5	16.0	kHz	6.0	601	
P1.17	Brake chopper	0	2		0	504	**0**=Disabled **1**=Used in Run state **2**=Used in Run and Stop state

Table 9.2: Motor settings

NOTE! These parameters are shown, when **P13.1 = 0**.

9.3 START/STOP SETUP (CONTROL PANEL: MENU PAR -> P2)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P2.1	Control place	1	3		1	125	**1** = I/O terminal **2** = Keypad **3** = Fieldbus
P2.2	Start function	0	1		0	505	**0** = Ramp **1** = Flying start
P2.3	Stop function	0	1		0	506	**0** = Coasting **1** = Ramp
P2.4	Start/Stop logic	0	3		0	300	**DI1** **DI2** **0** Start Fwd Start reverse **1** Start Reverse **2** Start Pulse Stop Pulse **3** Start Fwd Start Rv REAF REAF

Table 9.3: Start/stop setup

9.4 FREQUENCY REFERENCES (CONTROL PANEL: MENU PAR -> P3)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P3.1	Min frequency	0.00	P3.2	Hz	0.00	101	
P3.2	Max frequency	P3.1	320	Hz	50.00	102	
P3.3	I/O reference	0	4		3	117	**0** = Preset Speeds (0-7) **1** = Keypad Reference **2** = Fieldbus Reference **3** = AI1 **(API FULL & LIMITED)** **4** = AI2 **(API FULL)**
P3.4	Preset speed 0	0.00	P3.2	Hz	5.00	124	Activated by digital inputs
P3.5	Preset speed 1	0.00	P3.2	Hz	10.00	105	Activated by digital inputs
P3.6	Preset speed 2	0.00	P3.2	Hz	15.00	106	Activated by digital inputs
P3.7	Preset speed 3	0.00	P3.2	Hz	20.00	126	Activated by digital inputs
P3.8	Preset speed 4	0.00	P3.2	Hz	25.00	127	Activated by digital inputs
P3.9	Preset speed 5	0.00	P3.2	Hz	30.00	128	Activated by digital inputs
P3.10	Preset speed 6	0.00	P3.2	Hz	40.00	129	Activated by digital inputs
P3.11	Preset speed 7	0.00	P3.2	Hz	50.00	130	Activated by digital inputs

Table 9.4: Frequency references

NOTE! These parameters are shown, when **P13.1 = 0**.

9.5 RAMPS AND BRAKES SETUP (CONTROL PANEL: MENU PAR -> P4)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P4.1	Ramp shape	0.0	10.0	s	0.0	500	**0** = Linear **>0** = S-curve ramp time
P4.2	Acceleration time	0.1	3000	s	1.0	103	
P4.3	Deceleration time	0.1	3000	s	1.0	104	
P4.4	DC braking current	Unit dep.	Unit dep.	A	Varies	507	
P4.5	DC braking time at start	0.00	600.00	s	0	516	**0** = DC brake is off at start
P4.6	Frequency to start DC braking during ramp stop	0.10	10.00	Hz	1.50	515	
P4.7	DC braking time at stop	0.00	600.00	s	0	508	**0** = DC brake is off at stop

Table 9.5: Motor control parameters

9.6 DIGITAL INPUTS (CONTROL PANEL: MENU PAR -> P5)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P5.1	Start signal 1	0	6		1	403	**0** = Not used **1** = DI1 **2** = DI2 **Only in API FULL & LIMITED** **3** = DI3 **4** = DI4 **Only in API FULL** **5** = DI5 **6** = DI6
P5.2	Start signal 2	0	6		2	404	As parameter 5.1
P5.3	Reverse	0	6		0	412	As parameter 5.1
P5.4	Ext. fault Close	0	6		0	405	As parameter 5.1
P5.5	Ext. fault Open	0	6		0	406	As parameter 5.1
P5.6	Fault reset	0	6		5	414	As parameter 5.1
P5.7	Run enable	0	6		0	407	As parameter 5.1
P5.8	Preset speed B0	0	6		3	419	As parameter 5.1
P5.9	Preset speed B1	0	6		4	420	As parameter 5.1

Table 9.6: Digital inputs

Code	Parameter	Min	Max	Unit	Default	ID	Note
P5.10	Preset speed B2	0	6		0	421	As parameter 5.1
P5.11	Disable PI	0	6		6	1020	As parameter 5.1

Table 9.6: Digital inputs

9.7 ANALOGUE INPUTS (CONTROL PANEL: MENU PAR -> P6)

Code	Parameter	Min	Max	Unit	Default	ID	Note
Only in API FULL & LIMITED							
P6.1	AI1 Signal range	0	3		0	379	**API FULL and LIMITED:** **0** = Voltage 0…10 V **1** = Voltage 2…10 V **API LIMITED ONLY:** **2** = Current 0…20 mA **3** = Current 4…20 mA **NOTE:** When using API LIMITED, select the voltage/current range also with the dip switch
P6.2	AI1 filter time	0.0	10.0	s	0.1	378	0 = no filtering
P6.3	AI1 Custom min	-100.0	100.0	%	0.0	380	0.0 = no min scaling
P6.4	AI1 Custom max	-100.0	100.0	%	100.0	381	100.0 = no max scaling
Only in API FULL							
P6.5	AI2 signal range	2	3		3	390	**2** = Current 0…20 mA **3** = Current 4…20 mA
P6.6	AI2 filter time	0.0	10.0	s	0.1	389	0 = no filtering
P6.7	AI2 Custom min	-100.0	100.0	%	0.0	391	0.0 = no min scaling
P6.8	AI2 Custom max	-100.0	100.0	%	100.0	392	100.0 = no max scaling

Table 9.7: Analoque inputs

9.8 DIGITAL AND ANALOGUE OUTPUTS (CONTROL PANEL: MENU PAR -> P7)

Code	Parameter	Min	Max	Unit	Default	ID	Selections
Only in API FULL							
P7.1	Relay output 1 content	0	8		2	313	**0** = Not used **1** = Ready **2** = Run **3** = Fault **4** = Fault Inverted **5** = Warning **6** = Reversed **7** = At Speed **8** = Motor Regulator Active
In all API versions							

Table 9.8: Digital and analogue outputs

Code	Parameter	Min	Max	Unit	Default	ID	Selections
P7.2	Relay output 2 content	0	8		3	314	**As parameter 7.1**
Only in API FULL							
P7.3	Digital output 1 content	0	8		1	312	**As parameter 7.1**
P7.4	Analogue output function	0	4		1	307	**0** = Not in use **1** = Output freq. (0-f_{max}) **2** = Output current (0-I_{nMotor}) **3** = Torque (0-Nominal torque) **4** = PI controller output
P7.5	Analogue output minimum	0	1		1	310	**0** = 0 mA **1**= 4 mA

Table 9.8: Digital and analogue outputs

9.9 PROTECTIONS (CONTROL PANEL: MENU PAR -> P9)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P9.1	Response to 4mA reference fault	0	2		1	700	**0** = No response **1** = Warning **2** = Fault, stop acc. to P2.3
P9.2	Response to under voltage fault	0	2		2	727	
P9.3	Ground fault protection	0	2		2	703	
P9.4	Stall protection	0	2		0	709	
P9.5	Underload protection	0	2		0	713	
P9.6	Reserved						
P9.7	Thermal protection of the motor	0	2		0	704	
P9.8	Motor ambient temperature	-20	100	Fahrenheit (C)	40	705	
P9.9	Motor cooling factor at zero speed	0,0	150.0	%	40.0	706	
P9.10	Motor thermal time constant	1	200	min	45	707	

Table 9.9: Protections

NOTE! These parameters are shown, when **P13.1 = 0**.

9.10 AUTORESTART PARAMETERS (CONTROL PANEL: MENU PAR -> P10)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P10.1	Wait time	0.10	10.00	s	0.50	717	Delay before automatic restart after a fault has disappeared
P10.2	Trial time	0.00	60.00	s	30.00	718	Defines the time before the frequency converter tries to automatically restart the motor after the fault has disappeared
P10.3	Start function	0	2		0	719	**0** = Ramp **1** = Flying start **2** = According to P4.2
P10.4	Automatic restart	0	1		0	731	**0** = Disabled **1** = Enabled

Table 9.10: Autorestart parameters

NOTE! These parameters are shown, when **P13.1 = 0**.

9.11 PI CONTROL PARAMETERS (CONTROL PANEL: MENU PAR -> P12)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P12.1	PI activation	0	2		0	163	**0** = Not used **1** = PI for motor control **2** = PI for external use
P12.2	PI controller gain	0.0	1000	%	100.0	118	
P12.3	PI controller I-time	0.00	320.0	s	10.00	119	
P12.4	Keypad PI reference	0.0	100.0	%	0.0	167	
P12.5	Setpoint source	0	3		0	332	**0** = Keypad PI reference, P12.4 **1** = Fieldbus **2** = AI1 **Only in API FULL & LIMITED** **3** = AI2 **Only in API FULL**
P12.6	Feedback source	0	2		2	334	**0**= Fieldbus **1** = AI1 **Only in API FULL & LIMITED** **2** = AI2 **Only in API FULL**
P12.7	Feedback minimum	0.0	100.0	%	0.0	336	0 = No minimum scaling
P12.8	Feedback maximum	0.0	100.0	%	100.0	337	100,0 = No maximum scaling
P12.9	Error value inversion	0	1		0	340	**0**=No inversion (Feedback<Setpoint->Increase PI Output) **1**=Inverted (Feedback<Setpoint->Decrease PI Output)

Table 9.11: PI control parameters

NOTE! These parameters are shown, when **P13.1 = 0.**

9.12 EASY USAGE MENU (CONTROL PANEL: MENU PAR -> P0)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P13.1	Parameter conceal	0	1		1	115	**0** = All parameters visible **1** = Only quick setup parameter group visible
P13.2	Drive setup	0	3		0	540	**0 =** Basic **1 =** Pump drive **2 =** Fan drive **3 =** Conveyor drive (HP) **NOTE!** Visible only during Startup wizard

Table 9.12: Easy usage menu parameters

9.13 SYSTEM PARAMETERS

Code	Parameter	Min	Max	Default	Note
Software information (MENU PAR -> S1)					
S1.1	Software package				
S1.2	Power SW version				
S1.3	API SW version				
S1.4	API Firmware interface				
S1.5	Application ID				
S1.6	Application revision				
S1.7	System load				
RS485 information (MENU PAR -> S2)					
S2.1	Communication status				Format: **xx.yyy** **xx** = 0 - 64 (Number of error messages) **yyy** = 0 - 999 (Number of correct messages)
S2.2	Fieldbus protocol	0	1	0	**0 =** FB disabled **1=** Modbus
S2.3	Slave address	1	255	1	
S2.4	Baud rate	0	5	5	**0**=300, **1**=600, **2**=1200, **3**=2400, **4**=4800, **5**=9600,
S2.5	Number of stop bits	0	1	1	**0**=1, **1**=2
S2.6	Parity type	0	0	0	**0**= None (locked)
S2.7	Communication time-out	0	255	10	**0**= Not used, **1**= 1 second, **2**= 2 seconds, etc.

Table 9.13: System parameters

Code	Parameter	Min	Max	Default	Note
S2.8	Reset communication status				**1**= Resets par. S2.1
Total counters (MENU PAR -> S3)					
S3.1	MWh counter				
S3.2	Power on days				
S3.3	Power on hours				
User settings (MENU PAR -> S4)					
S4.1	Display contrast	0	15	7	Adjusts the display contrast
S4.2	Restore factory defaults	0	1	0	**1**= Restores factory defaults for all parameters

Table 9.13: System parameters

NOTE! These parameters are shown, when **P13.1 = 0**.

10. PARAMETER DESCRIPTIONS

On the next pages you can find the descriptions of certain parameters. The descriptions have been arranged according to parameter group and number.

10.1 MOTOR SETTINGS (CONTROL PANEL: MENU PAR -> P1)

1.8 MOTOR CONTROL MODE

With this parameter the user can select the motor control mode. The selections are:

0 = Frequency control:

The I/O terminal, keypad and fieldbus references are frequency references and the frequency converter controls the output frequency (output frequency resolution = 0.01 Hz)

1 = Speed control:

The I/O terminal, keypad and fieldbus references are speed references and the frequency converter controls the motor speed.

1.9 U/F RATIO SELECTION

There are three selections for this parameter:

0 = Linear:

The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point where the nominal voltage is supplied to the motor. Linear U/f ratio should be used in constant torque applications. See Figure 10.1.

This default setting should be used if there is no special need for another setting.

1 = Squared:

The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point where the nominal voltage is also supplied to the motor. The motor runs under magnetised below the field weakening point and produces less torque, power losses and electromechaniqal noise. Squared U/f ratio can be used in applications where torque demand of the load is proportional to the square of the speed, e.g in centrifugal fans and pumps

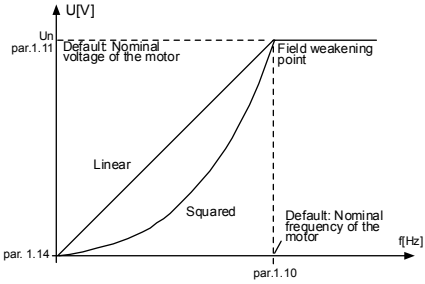


Figure 10.1: Linear and squared change of motor voltage

2 = Programmable U/f curve:

The U/f curve can be programmed with three different points. Programmable U/f curve can be used if the other settings do not satisfy the needs of the application

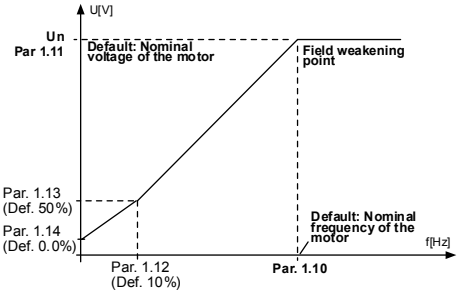


Figure 10.2: Programmable U/f curve

1.10 FIELD WEAKENING POINT

The field weakening point is the output frequency at which the output voltage reaches the value set with par. 1.11.

1.11 VOLTAGE AT FIELD WEAKENING POINT

Above the frequency at the field weakening point, the output voltage remains at the value set with this parameter. Below the frequency at the field weakening point, the output voltage depends on the setting of the U/f curve parameters. See parameters 1.9 - 1.14 and Figures 10.1 and 10.2.

When the parameters 1.1 and 1.2 (nominal voltage and nominal frequency of the motor) are set, the parameters 1.10 and 1.11 are automatically given the corresponding values. If you need different values for the field weakening point and the voltage, change these parameters after setting the parameters 1.1 and 1.2.

1.12 U/F CURVE, MIDDLE POINT FREQUENCY

If the programmable U/f curve has been selected with the parameter 1.9, this parameter defines the middle point frequency of the curve. See Figure 10.2.

1.13 U/F CURVE, MIDDLE POINT VOLTAGE

If the programmable U/f curve has been selected with the parameter 1.9, this parameter defines the middle point voltage of the curve. See Figure 10.2.

1.14 OUTPUT VOLTAGE AT ZERO FREQUENCY

This parameter defines the zero frequency voltage of the curve. See Figures 10.1 and 10.2.

1.15 TORQUE BOOST

The voltage to the motor changes automatically with high load torque which makes the motor produce sufficient torque to start and run at low frequencies. The voltage increase depends on the motor type and power. Automatic torque boost can be used in applications with high load torque, e.g. in conveyors.

0 = Disabled

1 = Enabled

Note: In high torque - low speed applications - it is likely that the motor will overheat. If the motor has to run a prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the temperature tends to rise too high.

1.16 SWITCHING FREQUENCY

Motor noise can be minimised using a high switching frequency. Increasing the switching frequency reduces the capacity of the frequency converter unit.

Switching frequency: 1.5…16 kHz.

1.17 BRAKE CHOPPER

Note! An internal brake chopper is installed in three phase supply MI2 and MI3 size drives

0 = No brake chopper used

1 = Brake chopper used in Run state

2 = Used in Run and Stop state

When the frequency converter is decelerating the motor, the energy stored to the inertia of the motor and the load are fed into an external brake resistor, if the brake chopper has been activated. This enables the frequency converter to decelerate the load with a torque equal to that of acceleration (provided that the correct brake resistor has been selected). See separate Brake resistor installation manual.

10.2 START/STOP SETUP (CONTROL PANEL: MENU PAR -> P2)

2.1 CONTROL PLACE

With this parameter, the user can select the active control place. The selections are:

1 = I/O terminal
2 = Keypad
3 = Fieldbus

Note: Local/Remote control mode can be toggled by pressing the navigation wheel for 5 seconds. P2.1 will have no effect in local mode.

Local = Keypad is the control place
Remote = P2.1 defines the control place

2.2 START FUNCTION

The user can select two start functions with this parameter:

0 = Ramp start

The frequency converter starts from 0 Hz and accelerates to the set frequency reference within the set acceleration time (P4.2). (Load inertia or starting friction may cause prolonged acceleration times).

1 = Flying start

The frequency converter is able to start also a running motor by applying a small torque to motor and searching for the frequency corresponding to the speed the motor is running at. The searching starts from the maximum frequency towards the actual frequency until the correct value is detected. Thereafter, the output frequency will be increased/decreased to the set reference value according to the set acceleration/deceleration parameters.

Use this mode if the motor is rotating when the start command is given. With the flying start, it is possible to ride through short mains voltage interruptions

2.3 STOP FUNCTION

Two stop functions can be selected in this application:

0 = Coasting

The motor coasts to a halt without control from the frequency converter after the Stop command.

1 = Ramp stop

After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters.

If the regenerated energy is high it may be necessary to use an external braking resistor for to be able to decelerate the motor in acceptable time.

2.4 START/STOP LOGIC

With this parameter the user can select the start/stop logic.

0 = DI1 = Start forward
DI2 = Start reverse **(API FULL & LIMITED)**

1 = DI1 = Start
DI2 = Reverse **(API FULL & LIMITED)**

2 = DI1 = Start pulse
DI2 = Stop pulse **(API FULL & LIMITED)**

3 = DI1 = Start forward, rising edge after fault
DI2 = Start reverse, rising edge after fault **(API FULL & LIMITED)**

10.3 FREQUENCY REFERENCES (CONTROL PANEL: MENU PAR -> P3)

3.3 I/O REFERENCE

Defines the selected frequency reference source when the drive is controlled from the I/O terminal.

0 = Preset speed 0 - 7
1 = Keypad reference
2 = Reference from Fieldbus (FBSpeedReference)
3 = AI1 reference (terminals 2 and 3, e.g. potentiometer)
4 = AI2 reference (terminal 4 and 5, e.g. transducer)

3.4 - 3.11 PRESET SPEEDS 0 - 7

These parameters can be used to determine frequency references that are applied when appropriate combinations of digital inputs are activated. Preset speeds can be activated from digital inputs despite of the active control place.

Parameter values are automatically limited between the minimum and maximum frequencies. (par. 3.1, 3.2).

Speed	Preset speed B2	Preset speed B1	Preset speed B0
If P3.3 = 0, Preset speed 0			
Preset speed 1			x
Preset speed 2		x	
Preset speed 3		x	x
Preset speed 4	x		
Preset speed 5	x		x
Preset speed 6	x	x	
Preset speed 7	x	x	x

Table 10.1: Preset speeds 1 - 7

10.4 RAMPS & BRAKES SETUP (CONTROL PANEL: MENU PAR -> P4)

4.1 RAMP SHAPE

The start and end of the acceleration and deceleration ramp can be smoothed with this parameter. Setting value 0 gives a linear ramp shape which causes acceleration and deceleration to act immediately to the changes in the reference signal.

Setting value 0.1…10 seconds for this parameter produces an S-shaped acceleration/deceleration. The acceleration and deceleration times are determined with parameters 4.2 and 4.3.

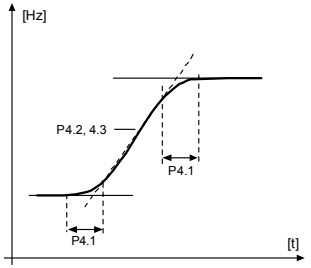


Figure 10.3: S-shaped acceleration/deceleration

4.5 DC BRAKING TIME AT START

DC-brake is activated when the start command is given. This parameter defines the time before the brake is released. After the brake is released, the output frequency increases according to the set start function by par. 2.2.

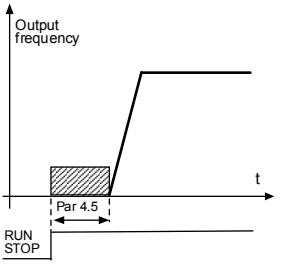


Figure 10.4: DC braking time at start

4.6 FREQUENCY TO START DC BRAKING DURING RAMP STOP

The output frequency at which the DC-braking is applied. See Figure 10.6.

4.7 DC BRAKING TIME AT STOP

Determines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, par. 2.3.

0 = DC brake is not in use

>0 = DC brake is in use and its function depends on the Stop function, (par. 2.3). The DC braking time is determined with this parameter.

Par. 2.3 = 0 (Stop function = Coasting):

After the stop command, the motor coasts to a stop without control from the frequency converter.

With the DC injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled by the frequency when the DC-braking starts. If the frequency is greater than the nominal frequency of the motor, the set value of parameter 4.7 determines the braking time. When the frequency is 10% of the nominal, the braking time is 10% of the set value of parameter 4.7.

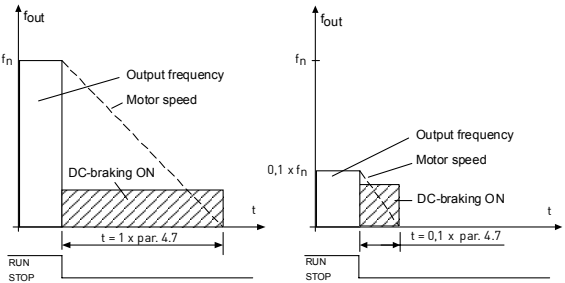


Figure 10.5: DC-braking time when Stop mode = Coasting

Par. 2.3 = 1 (Stop function = Ramp):

After the Stop command, the speed of the motor is reduced according to the set deceleration parameters, if the inertia of of the motor and load allows that, to the speed defined with parameter 4.6, where the DC-braking starts.

The braking time is defined with parameter 4.7. If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See Figure 10.6.

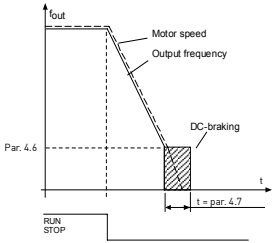


Figure 10.6: DC-braking time when Stop mode = Ramp

10.5 DIGITAL INPUTS (CONTROL PANEL: MENU PAR -> P5)

5.1 START SIGNAL 1
5.2 START SIGNAL 2
5.3 REVERSE
5.4 EXTERNAL FAULT (CLOSE)
5.5 EXTERNAL FAULT (OPEN)
5.6 FAULT RESET
5.7 RUN ENABLE
5.8 PRESET SPEED B0
5.9 PRESET SPEED B1
5.10 PRESET SPEED B2
5.11 DISABLE PI

The selections for these parameters are:

0 = Not used
1 = DI1
2 = DI2 (**API FULL & LIMITED**)
3 = DI3 (**API FULL & LIMITED**)
4 = DI4 (**API FULL**)
5 = DI5 (**API FULL**)
6 = DI6 (**API FULL**)

10.6 ANALOQUE INPUTS (CONTROL PANEL: MENU PAR -> P6)

6.2 AI1 SIGNAL FILTER TIME (ONLY IN API FULL & LIMITED)
6.6 AI2 SIGNAL FILTER TIME (ONLY IN API FULL)

This parameter, given a value greater than 0, activates the function that filters out disturbances from the incoming analogue signal.

Long filtering time makes the regulation response slower. See Figure 10.7.

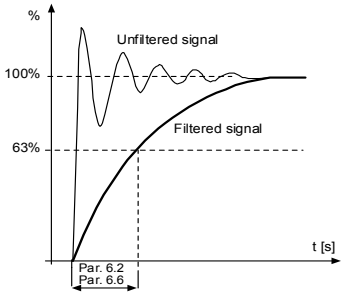


Figure 10.7: AI1 and AI2 signal filtering

10.7 DIGITAL AND ANALOQUE OUTPUTS (CONTROL PANEL: MENU PAR -> P7)

7.1 RELAY OUTPUT 1 FUNCTION
7.2 RELAY OUTPUT 2 FUNCTION (ONLY IN API FULL)
7.3 DIGITAL OUTPUT 1 FUNCTION (ONLY IN API FULL)

Setting	Signal content
0 = Not used	Not in operation
1 = Ready	The frequency converter is ready to operate
2 = Run	The frequency converter operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = Alarm	An alarm has occurred
6 = Reversed	The reverse command has been selected
7 = At speed	The output frequency has reached the set reference
8 = Motor regulator activated	One of the limit regulators (e.g. current limit, voltage limit) is activated

Table 10.2: Output signals via RO1, RO2 and DO1

10.8 MOTOR THERMAL PROTECTION (PARAMETERS 9.7 - 9.10)

The motor thermal protection is to protect the motor from overheating. The Honeywell drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that the motor will be thermally overloaded. This is the case especially at low frequencies. At low frequencies the cooling effect of the motor is reduced as well as its capacity. If the motor is equipped with an external fan the load reduction at low speeds is small.

The motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor.

The motor thermal protection can be adjusted with parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency.

CAUTION! The calculated model does not protect the motor if the airflow to the motor is reduced by blocked air intake grill

9.7 THERMAL PROTECTION OF THE MOTOR

0 = No response

1 = Warning

2 = Fault, stop mode after fault according to parameter 2.3

If tripping is selected the drive will stop and activate the fault stage. Deactivating the protection, i.e. setting parameter to 0, will reset the thermal model of the motor to 0%.

9.8 MOTOR AMBIENT TEMPERATURE

When the motor ambient temperature must be taken into consideration, it is recommended to set a value for this parameter. The value can be set between -4 °F (-20 °C) and 212 °F (100 °C).

9.9 MOTOR COOLING FACTOR AT ZERO SPEED

The cooling power can be set between 0-150.0% x cooling power at nominal frequency. See Figure 10.8.

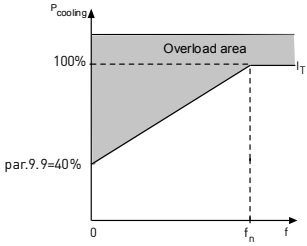


Figure 10.8: Motor cooling power

9.10 MOTOR THERMAL TIME CONSTANT

This time can be set between 1 and 200 minutes.

This is the thermal time constant of the motor. The bigger the motor, the bigger the time constant. The time constant is the time within which the calculated thermal model has reached 63% of its final value.

The motor thermal time is specific to the motor design and it varies between different motor manufacturers.

If the motor's t6-time (t6 is the time in seconds the motor can safely operate at six times the rated current) is known (given by the motor manufacturer) the time constant parameter can be set basing on it. As a rule of thumb, the motor thermal time constant in minutes equals to 2xt6. If the drive is in stop state the time constant is internally increased to three times the set parameter value. See also Figure 10.9.

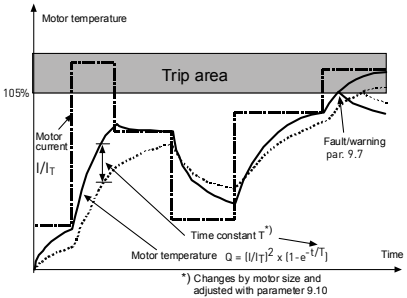


Figure 10.9: Motor temperature calculation

10.9 AUTORESTART PARAMETERS (CONTROL PANEL: MENU PAR -> P10)

10.2 AUTOMATIC RESTART, TRIAL TIME

The Automatic restart function restarts the frequency converter when the faults have disappeared and the waiting time has elapsed.

The time count starts from the first autorestart. If the number of faults occurring during the trial time exceeds three, the fault state becomes active. Otherwise the fault is cleared after the trial time has elapsed and the next fault starts the trial time count again. See Figure 10.10.

If a single fault remains during the trial time, a fault state is true.

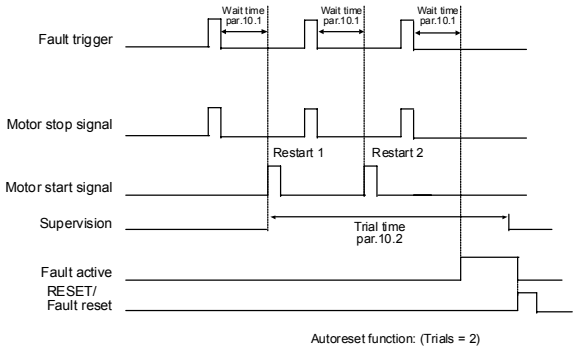


Figure 10.10: Automatic restart

10.10 PI CONTROL PARAMETERS (CONTROL PANEL: MENU PAR -> P12)

12.2 PI CONTROLLER GAIN

This parameter defines the gain of the PI controller. If the value of the parameter is set to 100% a change of 10% in the error value causes the controller output to change by 10%.

12.3 PI CONTROLLER I-TIME

This parameter defines the integration time of the PI controller. If this parameter is set to 1,00 second the controller output is changed by a value corresponding to the output caused from the gain every second. (Gain*Error)/s.

12.7 FEEDBACK MINIMUM
12.8 FEEDBACK MAXIMUM

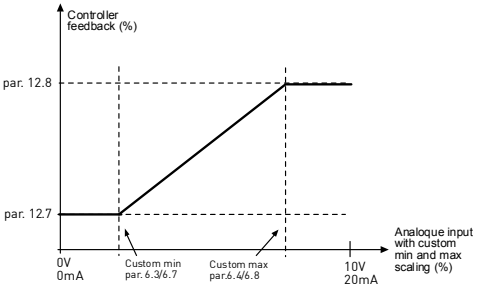


Figure 10.11: Feedback minimum and maximum

10.11 EASY USAGE MENU (CONTROL PANEL: MENU PAR -> P9)

13.2 DRIVE SETUP

With this parameter you can easily set up your drive for four different applications.

Note! This parameter is only visible when the Startup Wizard is active. The startup wizard will start in first power-up. It can also be started as follows. See the figures below.

NOTE! Running the startup wizard will always return all parameter settings to their factory defaults!

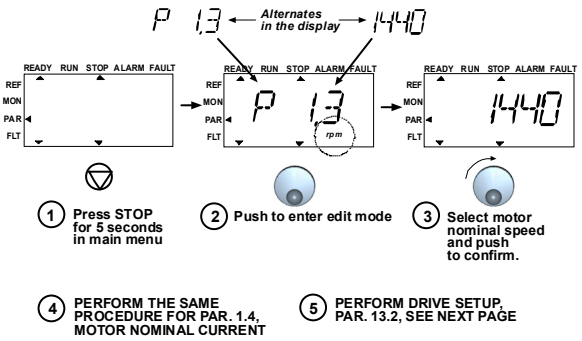
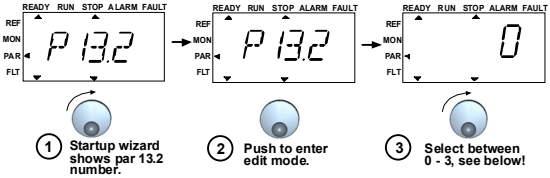


Figure 10.12: Startup wizard



Selections:

	P1.1	P1.2	P1.7	P1.15	P2.1	P2.2	P2.3	P3.1	P3.2	P3.3	P4.2	P4.3
0 = Basic	400 V*	50 Hz	1,1 * I_{NMOT}	0= Not used	I/O	0= Ramp	0= Coast.	0 Hz	50 Hz	0= Ai1 0-10V	3 s	3 s
1 = Pump drive	400 V*	50 Hz	1,1 * I_{NMOT}	0= Not used	I/O	0= Ramp	1= Ramp	20 Hz	50 Hz	0= Ai1 0-10V	5 s	5 s
2 = Fan drive	400 V*	50 Hz	1,1 * I_{NMOT}	0= Not used	I/O	0= Ramp	0= Coast.	20 Hz	50 Hz	0= Ai1 0-10V	20 s	20 s
3 = Conveyor drive	400 V*	50 Hz	1,5 * I_{NMOT}	1= Used	I/O	0= Ramp	0= Coast.	0 Hz	50 Hz	0= Ai1 0-10V	1 s	1 s

*In drives of 208V...230V this value is 230V

Parameters affected:

P1.1 Motor Un (V)
P1.2 Motor fn (Hz)
P1.7 Current limit (A)
P1.15 Torque boost
P2.1 Control place
P2.2 Start function
P2.3 Stop function
P3.1 Min frequency
P3.2 Max frequency
P3.3 I/O reference
P4.2 Acc. time (s)
P4.3 Dec time (s)

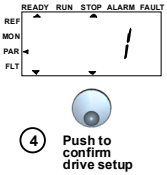


Figure 10.13: Drive setup

10.12 FIELDBUS PARAMETERS (CONTROL PANEL: MENU PAR -> S2)

The built-in Modbus connection supports the following function codes:

- 03 Read Holding Registers

- 04 Read Input Registers
- 06 Preset Single Registers

10.12.1 Modbus process data

Process data is an address area for fieldbus control. Fieldbus control is active when the value of parameter 2.1 (Control place) is 3 (=fieldbus). The contents of the process data has been determined in the application. The following tables present the process data contents in the GP Application.

Table 10.3: Output process data:

ID	Modbus register	Name	Scale	Type
2101	32101, 42101	FB Status Word	-	Binary coded
2102	32102, 42102	FB General Status Word	-	Binary coded
2103	32103, 42103	FB Actual Speed	0,01	%
2104	32104, 42104	Motor freq.	0,01	+/- Hz
2105	32105, 42105	Motor speed	1	+/- Rpm
2106	32106, 42106	Motor current	0,01	A
2107	32107, 42107	Motor torque	0,1	+/- % (of nominal)
2108	32108, 42108	Motor power	0,1	+/- % (of nominal)
2109	32109, 42109	Motor voltage	0,1	V
2110	32110, 42110	DC voltage	1	V
2111	32111, 42111	Active fault	-	Fault code

Table 10.4: Input process data:

ID	Modbus register	Name	Scale	Type
2001	32001, 42001	FB Control Word	-	Binary coded
2002	32002, 42002	FB General Control Word	-	Binary coded
2003	32003, 42003	FB Speed Reference	0,01	%
2004	32004, 42004	PI Control Reference	0,01	%
2005	32005, 42005	PI Actual value	0,01	%
2006	32006, 42006	-	-	-
2007	32007, 42007	-	-	-
2008	32008, 42008	-	-	-
2009	32009, 42009	-	-	-
2010	32010, 42010	-	-	-
2011	32011, 42011	-	-	-

Table 10.5: Status Word:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	Z	AREF	W	FLT	DIR	RUN	RDY

Information about the status of the device and messages is indicated in the Status word. The Status word is composed of 16 bits the meanings of which are described in the table below:

Table 10.6: Actual speed:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB															LSB

This is actual speed of the frequency converter. The scaling is -10000...10000. In the application, the value is scaled in percentage of the frequency area between set minimum and maximum frequency.

Table 10.7: Control word:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	-	-	-	-	RST	DIR	RUN

In Honeywell applications, the three first bits of the control word are used to control the frequency converter. However, you can customise the content of the control word for your own applications because the control word is sent to the frequency converter as such.

Table 10.8: Speed reference:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB															LSB

This is the Reference 1 to the frequency converter. Used normally as Speed reference. The allowed scaling is 0...10000. In the application, the value is scaled in percentage of the frequency area between the set minimum and maximum frequencies.

Table 10.9: Bit definitions:

Bit	Description	
	Value = 0	Value = 1
RUN	Stop	Run
DIR	Clockwise	Counter-clockwise
RST	Rising edge of this bit will reset active fault	
RDY	Drive not ready	Drive ready
FLT	No fault	Fault active
W	No warning	Warning active
AREF	Ramping	Speed reference reached
Z	-	Drive is running at zero speed

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62-0312—02 Rev. 05-09